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THE DIAGNOSTIC VALUE OF THE
EXAMINATION OF THE CEREBRO-SPINAL FLUID
IN CASES OF MENTAL DISORDER.

Being

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by

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INTRODUCTORY.

The clinical examination of the Cerebro-spinal fluid is a method of investigation which has been introduced comparatively recently. The existence of this substance was known by the latter half of the eighteenth century, but Majendie in 1825 was the first to give a detailed account of it, and it appears to be to this observer that we owe the name Cerebro-spinal fluid. In 1858 Claude Bernard added to the sum total of knowledge by describing the existence of a substance in the fluid which reduced Fehling's solution. During this period progress had been very slow, and no definite advance of note was made until the end of the nineteenth century. It is to Quincke that we owe the beginning of all the recent work that has been done on this subject. In 1891 he introduced Lumbar Puncture as a therapeutic measure. This method of treatment was employed in various diseases of the nervous system, but no distinct benefit was found to result. The operation was, however, followed by no bad results, and as the procedure was considered to be harmless to the patient, it began to be used with a view to investigate the nature of the fluid. It was largely used by French observers in cases of Meningitis, and the

results obtained were sufficiently encouraging to lead to its adoption as a means of clinical examination for diagnostic purposes. It thus came to be used in Meningitis of all kinds, in General Paralysis and in Tabes. More recently it has been employed in Sleeping Sickness. Owing to the introduction of Spinal Anaesthesia for surgical purposes the fluid has, within quite recent years, become of more importance to the Profession.

NATURE OF THE FLUID:

The Cerebro-spinal fluid differs in chemical and physical properties from the other fluids of the body; in its general characters it more closely resembles the sweat or the tears than any of the other secretions. In appearance it resembles water, it is a clear, limpid fluid. It has an alkaline reaction, and its specific gravity varies from 1006 to 1008. It is practically devoid of cellular elements, and contains only traces of protein matter - not more than .02%. Various salts are present, the chief of which is sodium chloride which exists to the extent of .6 to .7%. A copper reducing substance is present, and this Mott states to be glucose which he says is always present. This fluid exists at a certain pressure, which may be roughly estimated by the

number of drops which escape in a given time - a rate of flow of about 60 drops per minute is held to be about the normal pressure.

SOURCE OF THE FLUID:

The Choroid plexuses of the Lateral Ventricles are believed to be the source from which the fluid comes. These bodies are glandular in nature, having an external secretion which has an internal destination. This theory is supported by histological evidence. Cells lying on a basement membrane have been described, there are also tufts of vessels and nerve fibrils. Vacuoles are described in the cells, and some of them contain cup-like cavities. The general histological structure is very similar to that found in the Lachrymal gland. These facts all tend to strengthen the view that the Choroid plexuses are glandular. If they are glandular in function, then it is extremely likely that the fluid under consideration is their secretion. The results following on the mechanical interference with the escape of fluid from the lateral ventricles tend to support the theory that the choroid plexuses are the source of the cerebro-spinal fluid. Tumours of the third ventricle cause Internal Hydrocephalus, by hindering the escape of the fluid from the lateral ventricles.

If now it is assumed that the Choroid plexuses are the source of the fluid, then it is quite readily understood how mechanical interference with the escape of the fluid should cause an excess in the lateral ventricles, for the escape of the fluid is interfered with, while its source is left untouched.

The fluid thus produced finds its way into the subarachnoid space by the foramen of Majendie and the foramina of Luschka. It fills up all the crevices, and thus is more abundant at the base of the brain.

The normal quantity of fluid present is from 100 to 130 c.cs.. When any fluid is withdrawn, the deficiency appears to be very quickly made good and the original bulk restored. There are many cases on record where large quantities have escaped, in which speedy restoration has taken place. The Choroid plexuses therefore seem to be ever ready to respond to increased demands for fluid, and to secrete fluid to take the place of what has escaped. The question therefore arises whether these glands are continually secreting this substance, or whether they do so only when there is a demand for it. It seems more probable that the former view is correct, and that the fluid is normally continually being secreted. If this is the case, then there must be some means of escape for it. It is believed that the fluid does

have a means of escape, and that it normally finds its way into the venous system.

Some authorities hold that it escapes along the Lymphatics of the Cranial and Spinal nerves, reaches the Thoracic duct, and so gets into the veins. Some believe that there is a free communication between the Subarachnoid Space and the Longitudinal Sinus. Mott believes that the fluid gets into the venous blood by means of the capillaries. He comes to this conclusion from a study of the perivascular Lymphatic sheaths. These are delicate sheaths which surround the vessels of the central nervous system. The wall of the sheath is composed of delicate connective tissue, the external surface of the sheath is formed by the nervous substance, the internal surface is separated from the vessel by a space surrounding the vessel, this space being traversed by fine trabeculae. This space is filled by a clear transparent fluid. These sheaths are found in connection with the venules and arterioles, but stop short at the point where the small arterioles divide into capillaries; here the sheath is applied to the capillary wall, leaving no intervening space.

These sheaths are in direct communication with the Subarachnoid space of which they may be considered prolongations. Even after experimental ligation

of cerebral arteries producing artificial anaemia of the brain, these spaces are found to be filled with a clear fluid of non protein nature which is believed to be Cerebro-spinal fluid. This observation would lead us to conclude that whatever its source, the fluid cannot come directly from the blood. This canalicular system is found to communicate with the perineuronal spaces. There thus is demonstrated to exist a canalicular system surrounding the cells and vessels of the brain which communicates directly with the Subarachnoid space. This system contains a fluid which is believed to be the Cerebro-spinal fluid.

FUNCTIONS OF THE FLUID:

This fluid has most important functions to perform. It has certain mechanical effects. It surrounds the blood-vessels which have very thin walls, it thus helps to support the column of blood. It fills up the gaps and spaces in the Central Nervous System, and so helps to equalise the pressure. It acts as a water-cushion and protects the delicate structures of the brain from the effects of concussion.

These purely mechanical functions are easily

understood, but it is extremely unlikely that these are the only uses of the fluid. From its intimate relations to the nervous matter it is very probable that it has some active part to play in the body metabolism, that, in fact, it has some physiological function. It has been suggested that it is the medium of exchange between the neurons and the blood in the capillaries, that is to say, that it has the same relation to the neurons as ordinary lymph has to the other cells of the body. This theory is supported by the results found after injecting toxins which have a specific toxic action on the cells of the nervous system. When these are injected subcutaneously or intravenously little result is got compared with the marked toxic effects which follow on their being injected into the Subarachnoid Space. Lewandowsky demonstrated this by injecting Sodium ferrocyanide, and Behring by injecting Tetanus toxin. These investigations show that there is a much more intimate relation between the Cerebro-spinal fluid and the nerve cells, than there is between these cells and the blood. Experiments also indicate that while substances do not appear to pass readily from the blood to the fluid, they pass quickly from the fluid to the blood.

Most authorities are now agreed that the fluid

has a physiological function to perform, and that it really acts as lymph to the neurons. Professor Halliburton comes to the conclusion that the fluid is in the main a secretion, but that there are added the waste products of nervous activity, and so the fluid plays the part of lymph. Sir T. Barlow and Dr Lees in their article on Meningitis say:- "We may here add that Cerebro-spinal fluid as obtained from any point below the fourth ventricle cannot be an absolutely pure secretion; it must contain waste products resulting from cerebral metabolism, for into the subarachnoid space surrounding the brain open the lymphatic sheaths of all the cerebral arteries, and Dr Bevan Lewis has shown that the nerve cells of the brain are placed within pericellular sacs, each of which has a definite lymphatic connection with the wall of a small blood vessel." It may therefore be taken for granted that the fluid as got by Lumbar Puncture is not the same as that secreted by the Choroid plexuses. After leaving the plexuses it performs its physiological functions; and so, owing to the activities of metabolism certain changes have taken place in its chemical composition.

If the fluid, being the medium of exchange between the neurons and the blood, undergoes chemical changes during the processes of healthy metabolism,

it is reasonable to assume that in morbid conditions of the Central Nervous System there must be changes much more marked in the composition of the fluid. We would therefore expect diseased states of the Central nervous system to be accompanied by changes in the fluid, and would expect these changes to be proportionate to the amount of morbid change present. It is on this assumption that the fluid is examined in cases of Mental disorder.

OPERATION:

The skin was carefully prepared and strict Asepsis was maintained throughout. The patient was placed lying on the left side with the knees drawn up. The third Lumbar interspace was got, taking the Iliac crests as the guide, and the needle was introduced at the lower end of the space about one third of an inch to one side of the middle line. Fluid was allowed to flow into a graduated test-tube until 10 c.cs. were got, when the needle was withdrawn and the puncture sealed up. The patient remained in bed for the remainder of the day, and his head was kept low for some time after the operation.

METHOD OF EXAMINATION:

The pressure of the fluid was roughly estimated by the rate of flow from the needle.

Reaction: This was tested by Litmus paper.

Specific Gravity: This was determined by the use of beads.

The fluid was then taken, and poured into a conical glass test-tube, and centrifugalised at high speed for 15 minutes. This was considered sufficient time to get all the cellular elements to the bottom of the tube. The fluid was then decanted out of this tube, the last drop only being retained. This drop was well stirred up, so as to distribute the cells evenly; it was then taken up by a pipette and blown on to two glass slides. These slides were then dried, and stained by Jenner's and Leishman's blood stains; they were mounted, and so permanent slides were made.

The fluid which had been decanted off was taken and certain tests applied.

Albumen: A quantitative estimation of albumen was done by means of Esbach's Albuminimeter. For this purpose the fluid was always diluted with equal parts of distilled water.

The Noguchi Reaction: For this test there are two reagents necessary, (a) a solution of 10% Butyric Acid in normal Sodium Chloride solution, and (b) a 4% Sodium Hydrate solution. To perform the test, take 1 c.c. of the Cerebro-spinal fluid, and add to this 2.5 c.cs. of solution (a); this is boiled briefly, and then .5 c.c. of solution (b) is added, and again the mixture is boiled briefly. A positive result to this test is indicated by the appearance of a considerable flocculent white precipitate which begins to appear in a few seconds and gradually increases in amount. The precipitate gradually begins to settle down, and after the lapse of some time it all falls to the bottom of the tube.

This precipitate is due to the presence of globulin in the fluid, and the amount of the precipitate is an indication of the amount of globulin present. For this test it is therefore essential that the fluid be free from contamination with blood, as in the presence of blood no indication is given of the amount of globulin present in the fluid.

The Ross-Jones Test: The reagent required for this test is a saturated solution of ammonium sulphate. Two c.cs. of this solution are put into a test-tube, and one c.c. of the fluid to be tested is carefully run on to the surface of this, so that

there is a distinct line of junction between the two fluids. The appearance of a distinct ring at the junction of the fluids indicates a positive result. This ring is described as being "clear-cut, thin, greyish-white, having the thickness of a thin piece of paper". This ring should form within three minutes. The amount of proteid present in normal fluid is insufficient to give a ring with this solution, so that a positive result indicates a pathological increase of proteid in the fluid. The ring forms within three minutes, and within half an hour a delicate meshwork appears on the surface of the ring. The amount of proteid increase can be estimated by noting the density of the ring, and the time that elapses before its appearance. The more proteid there is, the denser is the ring and the more quickly does it appear. The increase of proteid here is due to globulin, this test indicating the amount of globulin increase.

Chlorides: For the quantitative estimation of Chlorides Mohr's Nitrate of Silver method was employed. Five c.cs. of the fluid were examined with a standard solution of Silver Nitrate.

Fehling's Test: A small quantity of the fluid was boiled with Fehling's Solution.

EXAMINATION OF THE CELLS:

The slides prepared and stained as already described were examined by the microscope. For purposes of description and counting the oil immersion lens was always used. For counting, a field under this power of magnification was taken as the standard, and the cells in this field were counted. This was done in ten fields, and an average of this total taken. This average is the result given in the detailed account of the cases, and is taken as a calculation of the number of cells present. When three or more lymphocytes are present in an average of ten fields, the presence of a Lymphocytosis is inferred.

THE CASES EXAMINED:

The cases selected for examination were all patients in the City of Newcastle Asylum, an Institution in which there are between 800 and 900 patients who are all drawn from this populous industrious centre. There is a large variety of clinical types to choose from, and among such patients one is not surprised to find the results of such aetiological factors as Syphilis and Alcohol. The patients chosen were chiefly those in whom it was thought there was some organic change underlying the Mental condition. So called functional cases were not examined unless the

Mental condition had existed for a long time, or the form of disorder was such as to suggest that there might be some fundamental brain-change present to account for it even in the absence of physical signs. Some were chosen because a positive diagnosis of General Paralysis had been made, others because they exhibited certain signs of Paralysis though the picture was not complete. Others were selected because there were signs of coarse organic changes in the brain, shown by paresis or paralysis, or the occurrence of Cerebral seizures. Others were chosen because there were definite changes produced which were believed to be caused by Alcohol.

The series of cases detailed here consists of 77 patients who were punctured, and from whom fluid was got which could be examined. For the purposes of comparing results, they are divided into classes, the classification being made from the Clinical standpoint. Of these 77, 32 were considered to be suffering from General Paralysis; in 11 General Paralysis was suspected but the diagnosis required confirmation. In ten the mental disorder was supposed to be due to the effects of Alcohol; two were cases of Insanity with the grosser brain lesions; two were Insanity following on Plumbism. There were three cases of Confusional Insanity, one of Dementia

following on Huntingdon's Chorea, and one of Imbecility consequent on Congenital Syphilis. The others were cases of Functional disorder. In seven of the General Paralytics a second examination was made after the lapse of three months.

The following are the details of the cases of General Paralysis.

Case 2: G.N. Male, age 37. The physical signs are well marked, and the disease is advanced. There is progressive feebleness and marked Mental deterioration, no grandiose delusions. He died within three weeks of puncture, having had a succession of severe convulsive seizures. Postmortem examination confirmed the diagnosis. No definite history of Syphilis. Fluid was got at increased pressure, Specific Gravity 1007.5, Noguchi test was positive, albumen .15%. Lymphocytes showed an average of 12 to the field; there were other cells present, one or two distinct Plasma cells being found.

Case 3: J.M. Male, age 40. Physical signs are distinctive. He had been admitted a year previously suffering from excitement; he soon became indifferent and apathetic, remaining in good health. He suddenly became depressed and began to deteriorate physically. When punctured he had become very thin,

and was stupid and resistive. He had no seizures. The diagnosis was confirmed by Post-mortem. Fluid was got at low pressure, Specific Gravity 1007.5, Noguchi negative, Albumen .1%. Lymphocytes were six to the field; other cells also occurred, among which were plasma cells.

Case 4: C.S. Male, age 33. He shows the typical clinical picture of advanced Paralysis. He is bed-ridden, there is advanced Dementia with boastfulness. He had two seizures during the disease. Post-mortem confirmed the diagnosis. There is a history of syphilis and he was very intemperate. Fluid was under high pressure, Specific Gravity 1007.5, Noguchi positive, Albumen .1%. There were numerous cells present, the lymphocyte count being 24. A second puncture, three months later, gave Specific Gravity 1007, Albumen .075%. The cell count had fallen, only 23 cells being found to the field, nine of which were lymphocytes. Chlorides were .74%.

Case 5: T.W. Male, age 40. He had been admitted six months previously in a mental condition closely resembling Delirium Tremens - great restlessness and excitement with visual hallucinations. This was soon replaced by the classical picture of Paralysis. He had a prolonged Cerebral convulsive attack

six months before being punctured, which was followed by marked deterioration. He died a fortnight after puncture, having had a second similar Cerebral attack. Syphilis eight years previously. Fluid was got at low pressure, Specific Gravity 1007, Noguchi positive, Albumen .07%. Cells were 14 to the field, only two of which were lymphocytes. There were some plasma cells made out.

Case 6: L.T. Male, age 49. The disease was advanced; he was profoundly demented, bedridden and helpless. There was complete disorientation, no delusions. He died a month later, during which time he had several seizures. Postmortem confirmed the diagnosis. Fluid was got at normal pressure. Specific Gravity 1007, Noguchi positive, Albumen .1%. Cell count was 15, a lymphocytosis of three. There were some plasma cells.

Case 7: R.N. Male, age 47. He was admitted nine months previously in a state of restless excitement with visual hallucinations; dementia soon became very marked. There were no grandiose delusions. He had a seizure a month after puncture, and no more. He died six months later, when a post-mortem established the diagnosis. He had had Syphilis. Fluid was got at low pressure, Specific Gravity 1007,

Noguchi positive. Cells were 29, a Lymphocytosis of seven; definite plasma cells were found. Albumen was .15%. The fluid three months later showed Specific Gravity 1006.75, Albumen .3%. Cell count had fallen to 14, Lymphocytosis being five. Chlorides .68%.

Case 9: W.C. Male, age 49. The disease was advanced. He was demented and indifferent, no delusions. He was feeble, and had had several seizures. There was a history of Syphilis. Fluid was at normal pressure, Specific Gravity 1007, Noguchi positive, Albumen .1%. The cell count was 20, Lymphocytosis being 15. There were distinct plasma cells. Three months later, Albumen was still .1%, cell count was 45, of which 24 were Lymphocytes; Chlorides were .74%.

Case 11: G.H.C. Male, age 44. The disease is advanced; there is dementia, mental exaltation is not prominent. There is a history of Syphilis. No seizures previous to puncture. Fluid came at low pressure, Specific Gravity 1007, Noguchi positive, Albumen .15%. Cell count was 36, seven being Lymphocytes. He had several seizures subsequent to the puncture. Three months later Albumen was .1%. Cell count was 14, lymphocytosis being three. There were definite plasma cells. Chlorides were .76%.

Case 12: J.W. Male, age 47. There is Dementia with childishness. He is in fair health, but has an occasional cerebral seizure. The disease does not progress much. Fluid was at very high pressure, Specific Gravity 1007, Noguchi positive, Albumen .1%. Cell count was 37 - a Lymphocytosis of 30. Three months later, Specific Gravity was 1005.5, Albumen .07%; cell count was still high; Chlorides were .72%.

Case 19: D.F. Female, age 34. The disease is advanced. She is profoundly demented, with loss of memory and complete disorientation. There had been only one seizure - a year previously. No positive history of Syphilis. Fluid escaped at low pressure. Specific Gravity 1007.5, Noguchi positive, Albumen .1%. Cell count was nine with a Lymphocytosis of eight. Three months later the cell count had fallen to seven, with a lymphocytosis of two. Chlorides were .76%.

Case 24: I.B. Female, age 35. There is Dementia with grandiose delusions. She was admitted three years previously, and during that time there had been some deterioration, but the progress of the disease was very slow. No seizures. Fluid was under normal pressure, Specific Gravity 1007, Noguchi

was not distinctly positive, Albumen .03%. The cells were six, all of which were Lymphocytes. Chlorides were .74%.

Case 27: S.W. Female, age 40. There is profound Dementia, and the disease is far advanced; she is feeble and bed-ridden. There have been no seizures. Fluid came at normal pressure, Specific Gravity 1005.25, Noguchi positive, Albumen .2%. Cell count was 30 with a Lymphocytosis of 26. There were plasma cells. Three months later albumen was .1%. Cell count was 28 with a Lymphocytosis of 19.

Case 34: T.H. Male, age 36. There is marked and progressive Dementia with grandiose delusions. He is in poor health, and has had occasional seizures. He has had Syphilis. Fluid was got at normal pressure, Specific Gravity 1007.25, Noguchi positive, Albumen .15%. The cell count was five, with a Lymphocytosis of four, no plasma cells. Chlorides .72%.

Case 45: G.C. Male, age 40. There is progressive Dementia with some emotional excitement. There are grandiose delusions. He has had an occasional seizure. He has had syphilis, and been very intemperate. Fluid came under normal pressure. Specific Gravity 1007, Noguchi positive, Albumen .15%. Cell count was 22 with two Lymphocytes only to the

field; there were no plasma cells.

Case 48: A. McG. Male, age 47. He was admitted six months previously with restless excitement, and extravagant delusions as to his ability. He became more easily managed, but there was little evidence of Dementia. He remained in this state until three months after being punctured when he took a series of 318 convulsive seizures within three days and died in Status Epilepticus. He had been very intemperate and there was a doubtful history of Syphilis. Fluid was under high pressure. Specific Gravity 1007, Noguchi positive, Albumen .087%. Cell count was 19, with a Lymphocytosis of three, no plasma cells. Chlorides were .72%.

Case 49: S.C.H. Male, age 42. There is Dementia with exaltation of ideas. He has had attacks of transient Aphasia, and an occasional seizure. He has had Syphilis, and was very intemperate. Fluid was under normal pressure, Specific Gravity 1007, Noguchi's test was not distinctly positive, Albumen .05%. Cell count was eight with a Lymphocytosis of three. No plasma cells. Chlorides .7%.

Case 53: J.W.L. Male, age 35. He was admitted a year previously in a state of Depression; this was soon replaced by a condition of indifference with

exaggerated feeling of well-being. The disease shows little tendency to advance, and there have been no seizures. He has had Syphilis. Fluid was contaminated with blood. Albumen .1%. Cell count was 12. Chlorides .72%.

Case 74: W.B.P. Male, age 55. He is facile and childish, and is irritable. There is exaggerated feeling of well-being, but no delusions. He has had two seizures, each resulting in right-sided Paresis with Aphasia. There is no positive history of Syphilis; he had a severe head injury sixteen years ago. Fluid was got at normal pressure. Specific Gravity 1007, Noguchi positive, Albumen .15%. Cell count was 13 with a Lymphocytosis of four. Chlorides .72%.

Case 83: E.H. Female, age 55. This patient was admitted three years ago with a partial picture of Paralysis; now the picture is complete; there is progressive Dementia with loss of memory and indifference. The course of the disease is very slow, and she shows little change. There have been no seizures. Fluid was got at normal pressure, Specific Gravity 1006, Noguchi positive, Albumen .1%. Cell count was 32 with a Lymphocytosis of three. Chlorides .72%.

Case 92: J.C. Male, age 52. He is demented, is restless and his habits are degraded. The classical delusions are present. There have been no seizures. He has had Syphilis, and has been very intemperate. Fluid came at normal pressure, Specific Gravity 1007, Noguchi positive, Ross-Jones test was distinctly positive, Albumen .175%. Cell count was 25 with a Lymphocytosis of 21.

Case 93: F.C.S. Male, age 35. This patient is childish, boastful, and has the typical grandiose delusions. His case is unusual in that the disease does not advance much. There have been no seizures, and the history is defective. Fluid was got at normal pressure, Specific Gravity 1008.75. Noguchi test was doubtfully positive; Ross Jones was positive but to a less degree. Albumen .06%. The cell count was high, and there was a Lymphocytosis.

Case 95: C.B.L. Male, age 38. There is progressive Dementia with grandiose delusions. There have been no fits. The disease was far advanced, and he died six days after puncture. He has had Syphilis. Fluid came under normal pressure. Specific Gravity 1007.25, Noguchi positive, Ross Jones positive, Albumen .1%. Cell count was 19, there being a Lymphocytosis of 15.

Case 97: J.J.R. Male, age 45. He is demented, being very facile and childish, no delusions. There have been no seizures; he has had Syphilis. Fluid was under increased pressure, Specific Gravity 1007.25, Noguchi and Ross Jones tests both positive, Albumen .075. Cell count was 19 with a Lymphocytosis of 14.

Case 99: R.H. Male, age 34. He is facile, childish, emotional and restless, his memory is very defective. There have been no seizures. He has had Syphilis, and was very intemperate. Fluid came at normal pressure, Specific Gravity 1007.25, Noguchi and Ross Jones tests were positive, Albumen .14%. Cell count was 21 with a Lymphocytosis of 18.

Case 100: W.T. Male, age 43. He is restless, boastful and has grandiose ideas; the disease is in the early stages and there is little Dementia. There have been no seizures. He has had Syphilis. Fluid came at low pressure, Specific Gravity 1007.25, Noguchi and Ross Jones tests were positive, Albumen .075. Cell count was 61, with a Lymphocytosis of 54.

Case 107: A.A. Male, age 46. He is in the last stages, is profoundly demented; he is bed-ridden, and has an occasional seizure. Fluid was

under normal pressure, Specific Gravity 1007.25, Noguchi and Ross Jones tests were positive, Albumen .125%. Cell count was 12 with a Lymphocytosis of six.

Case 111: J.A.S. Male, age 35. This patient is in the early stages, and was certified because his misdirected activity was leading him into business difficulties. He is exalted in manner and conversation, but is rational; there is no Dementia. There have been no seizures. He has had Syphilis. Fluid was got at low pressure, Specific Gravity 1007.25, Noguchi and Ross Jones both positive, Albumen .1%. The cell count was high, a Lymphocytosis of 54 being present.

Case 116: D.W.S. Male, age 32. The disease is advanced. There is Dementia with indifference and defective memory. There have been no seizures, he has had Syphilis. Fluid was under high pressure, Specific Gravity 1007.5, Noguchi and Ross Jones both positive, Albumen .15%. The cell count was 20, there being a Lymphocytosis of six.

Case 119: P.J.K. Female, age 33. There is marked Dementia with no delusions. There is progressive deterioration, she is helpless and bed-ridden. She is in the last stages. There have been

no seizures. Fluid was got at low pressure, Specific Gravity 1007.25, Noguchi and Ross Jones both positive, Albumen .1%, Lymphocytosis of three.

Case 40: J.A. Male, age 31. He is a paralytic with marked Tabetic signs; he exhibits Tabetic gait, Rombergism, and loss of knee-jerks. There are grandiose delusions, he is restless but there is little Dementia. There have been no seizures; he had Syphilis. Fluid was got at low pressure, Specific Gravity 1007, Noguchi positive, Albumen .1%. Cell count was 11, with one Lymphocyte to the field. Chlorides were .74%.

Case 103: T.G.W. Male, age 39. There is Dementia, with exaggerated feeling of well being and characteristic delusions. There have been no seizures, the disease does not advance at present. Fluid was under normal pressure, Specific Gravity 1007, Noguchi and Ross Jones positive, Albumen .1%. Cell count was eight with a Lymphocytosis of seven.

Case 25: V.A.B. Female, age 33. She was admitted two years previously with a mental condition closely resembling Imbecility. General Paralysis was at that time suspected, and in the interval the signs have become quite definite. Subsequent to puncture she had a large number of seizures, and died.

Post-mortem showed well marked Paralysis. She was bed-ridden and very helpless when examined. Fluid was got at normal pressure, Specific Gravity 1006, Noguchi positive, Albumen .05%. Field showed only an occasional cell, no Lymphocytes. Chlorides were .76%.

In these 32 cases of General Paralysis the results are strikingly uniform. The pressure under which the fluid comes is variable; specific Gravity varies between 1005.5 and 1008.75, but is usually about 1007. The Chlorides are between .68% and .76%. Noguchi's test is distinctly positive in all except three cases, in which the result is hardly definite enough to be called positive - that is, the result is definitely positive in 91% of the cases examined. In eleven cases Ross-Jones test was applied, and in all of them a positive result was got. In every case except one the result is very decidedly positive; in this one case the result was rather slow to appear and the degree was slight. It is interesting to note that in that case (No.93) Noguchi's test was not considered distinctly positive. An excessive amount of Albumen is found in all the cases. In only one case (No.24) was it below .05%, here on the first occasion it was .03% and on the second .04.

In all the others there was .05 or over. Usually the amount was .1 or above. The highest recorded was .3%. A subsequent examination sometimes showed an increase, and sometimes a decrease. A high cell count is got in all the cases with one exception. The total cell count varies within wide limits, as many as 60 being found. A definite Lymphocytosis (three or more) is found in every case with two exceptions, the highest number got was 54.

The next series of cases is composed of those patients who presented certain features of General Paralysis, but in whom the diagnosis was doubtful.

Case 1: W.T. Male, age 45. Here the diagnosis lies between General Paralysis and Dementia supervening on Disseminated Sclerosis. He presents Nystagmus, Syllabic speech, and increased reflexes; there is no Intention Tremor. Tongue and Pupils show little to note. He is demented, he is childish and his memory is defective, but he has not lost the Auto-critical faculty. He is unduly hopeful, but recognises the fact that his mental state is not what it has been. He has had an occasional seizure. Fluid was got at low pressure, Specific Gravity 1007.5, Noguchi negative, Albumen .07%. Cell count was six with a Lymphocytosis of four. No plasma cells.

Case 14: T.H. Male, age 48. Here the speech is characteristic of Paralysis. He is demented, his memory is defective, there are no delusions. During his three years' residence he has shown little change. He has had an occasional seizure. The disease is non-progressive. He has been very intemperate, and there is a doubtful history of Syphilis. Fluid was under high pressure, Specific Gravity 1007, Noguchi Negative, Albumen .03%. Cell count three, only an occasional lymphocyte.

Case 20: M.K. Female, age 45. Here the diagnosis lay between Dementia Paralytica and Korsakow's Polyneuritic Psychosis. The pupil reactions were sluggish, the tongue tremulous and the knee reflexes absent. Mentally there were illusions of memory with childishness and outbursts of noisy excitement. She had been very intemperate; there was no definite history of Syphilis but she had had repeated miscarriages. Fluid came at low pressure, Specific Gravity 1007.5, Noguchi negative, Albumen .05%. Cell count was four, a Lymphocytosis of three.

Case 29: G.J. Female, age 54. Here there is a partial picture - as far as physical signs are concerned. She is excitable and restless, has aural hallucinations and delusions of persecution. She

is exalted and boastful. She has changed little during seven years. No seizures. There is no satisfactory history. Fluid came at low pressure, Specific Gravity 1007, Noguchi positive, Albumen .05%. Cell count was 13, there being a Lymphocytosis of nine; no plasma cells.

Case 47: J.H. Male, age 45. There are certain physical signs of Paralysis. Mentally there is childishness with a tendency to exaggerated emotionalism. There is no marked Dementia. He has remained in much the same state for the last three years. He had a seizure three years ago. The course of the disease is non-progressive. He has been very intemperate, and there is no definite history of Syphilis. Fluid was got at low pressure, Specific Gravity 1007, Noguchi positive, Albumen .05%. Cell count was two with only an occasional Lymphocyte. Chlorides were .7%.

Case 50: C.L. Male, age 38. Here the pupils are characteristic of Dementia Paralytica, the other physical signs are not very definite. He is demented, there is complete disorientation and he is stupid and confused. The auto-critical faculty is not entirely gone. There have been several seizures. Fluid was got at high pressure, Specific Gravity 1007,

Noguchi positive, Albumen .1%. Cell count was ten, with two Lymphocytes. Chlorides .7%.

Case 73: W.K. Male, age 60. There are certain physical signs present. There is a degree of Dementia which does not tend to progress. The remarkable thing is that he has been in much the same state for the last seventeen years, without showing any marked change. He has been very intemperate, but there is no history of Syphilis. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .03. No Lymphocytes, an occasional indefinite cell being present. Chlorides were .74%.

Case 82: H.F. Female, age 31. This patient was admitted two years ago in a condition of acute Mental Depression. This lasted for eighteen months, when it was replaced by excitement with grandiose delusions. At the same time her physical condition was such as to suggest General Paralysis - her pupils and speech being affected. Fluid was got at normal pressure, Specific Gravity 1006, Noguchi negative, Albumen .03%. Cells were very scanty, no Lymphocytes being found. Chlorides were .76%.

Case 98: J.T.T. Male, age 50. This patient

exhibits Spinal Myosis, otherwise the physical signs are indefinite. He is childish, indifferent and apathetic, there is marked Mental deterioration. The attack began six months previously, with grandiose delusions which have since disappeared. He is bed-ridden. He has been very intemperate, and there is a positive history of Syphilis. Fluid came at normal pressure, Specific Gravity 1007.25, Noguchi and Ross Jones both positive, Albumen .05. Cell count was 37 with a Lymphocytosis of 33.

Case 108: J.C.S. Male, age 49. He presents the speech and tongue signs of Paralysis, but the pupils are normal. He is demented, restless and boastful. Though the picture is not complete, the Clinical course has been typical. There has been marked mental and physical deterioration; he has had several convulsive seizures with Aphasia followed by prolonged muscular twitching. The diagnosis of General Paralysis was confirmed by Post-mortem. He received a severe head injury five years ago; Syphilis is probable but not certain. Fluid was got at low pressure, Specific Gravity 1007, Noguchi and Ross Jones positive, Albumen .075. There was a high cell count, the cells were indistinct and a definite Lymphocytosis could not be demonstrated.

Case 118: E.G. Female, age 37. Four years ago this patient had an Apoplexy resulting in right Hemiplegia with spasticity and increased reflexes. She also exhibits some signs of Dementia Paralytica. She is childish, emotional, and her memory is defective, no delusions. She has had no seizures. Fluid was got at increased pressure, Specific Gravity 1007, Noguchi and Ross Jones positive, Albumen .1. Cells three to the field, one being a Lymphocyte.

In this group, as one might expect, the results are very divergent; the examination was in many cases of great assistance in coming to an accurate diagnosis.

The next cases are three of Confusional Insanity.

Case 17: J.W. Male, age 47. He was admitted a month previously suffering from Confusion with Aur-al hallucinations. There were certain physical signs of General Paralysis - sluggish pupils and muscular tremors. He made a complete recovery from the Confusion, and at the time of examination this had passed off. He was subsequently discharged. There was always a suspicion that he was suffering from an early stage of Paralysis. There was a definite history of Syphilis. Intemperance was the cause of the Mental breakdown. Fluid was got at increased pressure,

Specific Gravity 1007, Noguchi positive, Albumen .05. Cell count was three, two of which were Lymphocytes.

Case 42: J.H. Male, age 56. He was admitted a month previously in a confused state, his memory was a complete blank and there was marked disorientation. He exhibited tremulousness, and involuntary muscular jerkings; Babinski's sign was present on the left side. The state of Confusion cleared up, leaving a degree of mild Dementia. There had been no fits; he was very intemperate.

Fluid was got at high pressure, Specific Gravity 1007, Noguchi negative, Albumen .05; no cells found, Chlorides .74.

Case 110: P.S. Male, age 43. He was admitted six weeks previously in a confused and stupid condition, he could give no account of himself. His speech was thick and slurring, and he was unable to use his lower limbs. Improvement began in ten days, and continued steadily, until when punctured there was little to note mentally or physically. The attack was of three days' duration on admission. He had been temperate, but there is a vague history of some alcoholic indulgence just before the onset. Fluid was got at increased pressure, Specific Gravity 1007.25, Noguchi and Ross-Jones negative, Albumen .04.

There was only an occasional cell, no Lymphocytes.

These three cases, with the exception of the first which may possibly be General Paralysis, show mostly negative results.

The next cases are two where there are coarse brain lesions.

Case 51: J.W. Male, age 63. He was admitted six years ago in a condition of Dementia with exaltation of ideas. Two years ago he suffered from Apoplexy which resulted in Right Hemiplegia. He has had no seizures. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .05. There was an occasional cell, no Lymphocytes. Chlorides were .72.

Case 61: W.J. Male, age 63. This patient suffers from left Hemiplegia. He is demented, he is emotional, depressed, and believes he is the object of persecution by those about him. He had a Convulsive Seizure three months before being punctured. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .05. Cell count was three, no Lymphocytes. Chlorides .74.

There are two cases of Mental Disorder following Lead-poisoning.

Case 28: J.G. Female, age 49. She was admitted a year previously suffering from Mania, and exhibiting well-marked signs of Plumbism. Since then Dementia has been established, and at the time of examination was advanced. She never had any seizures. She died six months later. Post-mortem revealed marked Cerebral Atrophy. She had been a white lead worker for over thirty years. Fluid was got at low pressure, Specific Gravity 1007, Noguchi positive, Albumen .075. There was an occasional cell, no Lymphocytes. Chlorides .74.

Case 106: T. McC. Male, age 47. This patient exhibits a mild degree of Dementia with outbursts of post-epileptic Maniacal excitement. He is a white lead worker, and suffered from lead-poisoning eight years ago. Five years ago he developed Epilepsy; the seizures are of the general convulsive type, and occur twice or thrice a month. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi and Ross-Jones both negative, Albumen .04. There was an occasional cell, no Lymphocyte.

The next is a case of Dementia following on Huntington's Chorea.

Case 105: T.C. Male, age 60. He exhibits the

typical physical signs of the disease. Mentally there is Dementia which does not progress; there are also present the irritability and chronic discontent which are so characteristic. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Ross-Jones Test gave the suspicion of a positive result, Albumen .04. An occasional cell, no Lymphocytes.

This case is very interesting from the fact that so little is known of the exact Pathology of this disease. Most authorities believe that it is really a Meningo-encephalitis with Cerebral Atrophy. If this be so, one would expect to get changes in the fluid similar to those found in Dementia Paralytica. Here such changes were not got, and the only result suggesting such a condition was the doubtfully positive reaction to the Ross-Jones Test. In all other respects the fluid differs entirely from that got in cases of Dementia Paralytica.

The next group of cases is composed of those in which Alcohol was believed to be the chief cause. From the Clinical standpoint the group is somewhat heterogeneous, the only factor common to all is a history of Alcoholic excess.

Case 16: J.H. Male, age 40. This is a case

of Dementia, he is stupid, indifferent, and his memory is defective. There is evidence of some Peripheral Neuritis. He has had several Cerebral seizures. He was very intemperate for years. Fluid was got at increased pressure, Specific Gravity 1006.75, Noguchi positive, Albumen .05. There was only an occasional cell, no Lymphocytes being found.

Case 36: G.H. Male, age 44. This is a case of partial Dementia with a degree of restless excitement; there are aural hallucinations. During the last three years he has shown very little change. He has had several Cerebral Seizures. Fluid was got at low pressure, Specific Gravity 1007.25, Noguchi negative, Albumen .05. Cell count was seven with a Lymphocytosis of three. Chlorides were .74.

Case 37: J.L. Male, age 42. This is a case of partial Dementia which does not progress. He is indifferent and apathetic. He was admitted three months previously in a confused state with visual and aural hallucinations, and delusions of persecution. There have been no seizures. He has been very intemperate. Fluid was got at increased pressure, Specific Gravity 1007.5, Noguchi negative, Albumen .05. An occasional cell, no Lymphocytes. Chlorides .72.

Case 41: J.R. Male, age 56. This is a case of non-progressive partial Dementia, he is suspicious and deluded. He exhibits muscular tremulousness. He has had no fits, he was a very intemperate man. Fluid was got at normal pressure, Specific Gravity 1007.25, Noguchi positive, Albumen .04. A few cells were found with an occasional Lymphocyte. Chlorides .74.

Case 54: H.D. Male, age 37. This is a case of Chronic Delusional Insanity with aural hallucinations. He is indifferent and apathetic. There have been no seizures. He was very intemperate; his father was also very alcoholic, Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .05. Cell count was four, with an occasional Lymphocyte. Chlorides .74.

Case 55: G.A. Male, age 55. This is a case of Delusional Insanity with hallucinations of hearing and delusions of persecution. He has been a very eccentric person all his life, and has been intemperate. Fluid was got at normal pressure, Specific Gravity 1006, Noguchi negative, Albumen .075. An occasional cell, no Lymphocytes. Chlorides .74.

Case 59: J.F. Male, age 48. This patient was admitted nine years ago, when he was partially de-

mented and had hallucinations of hearing. He is now contented and very childish. He has had several seizures at long intervals. He was very intemperate. Fluid was got at increased pressure, Specific Gravity 1006.5, Noguchi negative, Albumen .04. An occasional cell, no Lymphocytes. Chlorides .72.

Case 96: G.B. Male, age 58. This is a good example of Korsakow's disease. There is Peripheral Neuritis, with marked illusions of memory; he gives a vivid account of events which never have taken place. The illness began a month before his admission with pains and cramps in the calves. He has had no fits. He was very intemperate for years. Fluid came under low pressure, Specific Gravity 1007.5, Noguchi and Ross-Jones negative, Albumen .075. Only an occasional cell was present.

Case 102: G.T.H. Male, age 60. This is a case of Dementia. He began to take epileptic seizures about eight months previous to being punctured. They are severe generalised convulsions. His pupils do not react to light, otherwise physical examination is negative. He was very intemperate for years. Fluid came under increased pressure, Specific Gravity 1007.25, Noguchi and Ross-Jones negative, Albumen .05. The cell count in this case was as high as 27, two of which were Lymphocytes.

Case 113: D.C. Male, age 50. Six months previously he was admitted in a confused condition which has passed off leaving a condition of mild Dementia. There was some right-sided paresis on admission. He has had no seizures, so far as known. He was a very intemperate man. Fluid was got at low pressure, Specific Gravity 1007, Noguchi and Ross-Jones negative, Albumen .04. An occasional cell, no Lymphocytes.

The results in these cases show a certain amount of variation which would be accounted for by the different Clinical types. The results differ markedly from those in Dementia Paralytica. The amount of albumen is moderate, the cell count is low, Noguchi test is rarely positive, and Ross-Jones always negative.

The next case is one of Imbecility with Congenital Syphilis.

Case 109: J.A. Male, age 15. He is childish and eccentric. He has the typical facial appearances, is deaf, and his vision is very defective. He does not suffer from Epilepsy, and there are no other signs pointing to disease of the nervous system. Fluid came under very high pressure, Specific

Gravity 1007, Noguchi and Ross-Jones were negative, Albumen .025. An occasional cell was present, no Lymphocytes.

It is interesting to note that the results here are chiefly negative.

The remaining cases - fifteen in all - are grouped together as Functional. This is done because there appears to be no definite physical cause underlying the mental state. Clinically they show great differences, and belong to several distinct types of mental disease.

Case 44: R.C. Male, age 33. This is a case of Dementia with marked apathy and indifference. He had infantile convulsions, and in early adult life developed Epilepsy. Fluid came at increased pressure, Specific Gravity 1007, Noguchi negative, Albumen .05. An occasional cell, no Lymphocytes. Chlorides .69.

Case 32: T.L. Male, age 30. This is a case of Imbecility with mental exaltation and delusions of grandeur. There were Athetoid movements of the upper limbs, and speech was very defective. He became feeble and bedridden with progressive physical and mental deterioration - the condition closely

resembling Advanced General Paralysis. Fluid was got at normal pressure, Specific Gravity 1006, Albumen .04, an occasional cell, no Lymphocytes. Chlorides .72.

Case 8: J.B. Male, age 29. This is a case of Secondary Dementia following on Mania ten years previously. Fluid was got at increased pressure, Specific Gravity 1007, Noguchi positive, Albumen .075. An occasional Lymphocyte was present.

Case 39: J.N. Male, age 25. This is a case of Dementia coming on insidiously in early adult life, beginning with apathy and loss of interest. He is stupid, and quite indifferent. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .03. The cell count was two with one lymphocyte to the field. Chlorides .74.

Case 62: A.L. Male, age 26. This is a case of Dementia with childishness, restlessness and considerable exaltation of ideas. Fluid was got at high pressure, Specific Gravity 1007, Noguchi negative, Albumen .05. A cell count of one or two to the field. Chlorides .74%.

Case 90: J.C. Male, age 36. This is a case of Dementia of some years' duration. There are no

physical signs of note, there is a history of Syphilis. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi's test was positive, Albumen .06. An occasional cell, no Lymphocytes. Chlorides .78.

Case 91: A.H. Male, age 34. This is a case of Secondary Dementia following on an attack of Mania. Fluid came at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .03. An occasional cell, no Lymphocytes, Chlorides .76.

Case 114: G.C. Male, age 30. This patient exhibits childishness, indifference and apathy, with aural hallucinations. There is a definite history of Syphilis eleven years previously. It was thought that the condition might be early General Paralysis. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi and Ross Jones both negative, Albumen .04. An occasional cell, no Lymphocytes.

Case 115: E.S. Male, age 29. This is a weak minded person who developed delusions of persecution and hallucinations of hearing necessitating his being certified as insane. Fluid was got at normal pressure, Specific Gravity 1007.25, Noguchi and Ross-Jones negative, Albumen .05. An occasional cell, no Lymphocytes.

Case 117: J.R.L. Male, age 31. Two months previous to examination, he was admitted in a maniacal state with exaltation of ideas. Since then he has become indifferent and quite contented with his lot, and appears to have lost all ambition and interest in his former life. The diagnosis appeared to lie between Dementia Praecox and General Paralysis. Fluid was got at low pressure, Specific Gravity 1007, Noguchi and Ross-Jones were negative, Albumen .03. No cells found.

Case 78: E.H. Female, age 58. This is a case of Mania of two years' duration, with excitement and erotic ideas. Fluid was got at normal pressure, Specific Gravity 1007, Noguchi negative, Albumen .06. A few cells were present, no Lymphocytes, Chlorides .74.

Case 56: W.G. Male, age 40. This is a case of Recurrent Melancholia, he is morose, reticent, is impulsive and has aural hallucinations. Fluid was got at very high pressure, Specific Gravity 1007, Noguchi positive, Albumen .05, Cell count two with an occasional Lymphocyte. Chlorides .72.

Case 57: W.N. Male, age 35. This is a case of Melancholia of over two years' duration; he is always depressed and suicidal, and is at times very restless. Fluid was got at very high pressure,

Specific Gravity 1005.5, Noguchi positive, Albumen .05. Cell count was two, a very occasional Lymphocyte being present. Chlorides .67.

Case 58: R.E.B. Male, age 40. He has had delusions of persecution for ten years; he is eccentric, hypochondriacal, and believes his food is being poisoned. Fluid was got at high pressure, Specific Gravity 1006.5, Noguchi negative, Albumen .05. Cell count was two with an occasional Lymphocyte. Chlorides .76.

Case 26: M.J.S. Female, age 59. This is a case of Dementia with occasional outbursts of excitement. Fluid was got at normal pressure, Specific Gravity 1007.5, Noguchi negative, Albumen .03. The cell count showed a very occasional Lymphocyte.

As compared with the cases of General Paralysis the striking thing about the Functional cases is the negative character of the various tests applied.

EFFECTS OF THE OPERATION:

In none of the cases examined were there any unpleasant after-effects. Confining the patient in

bed for the rest of the day and keeping his head low appear to obviate any unpleasant results. Headache and a feeling of malaise have been described as occurring after the withdrawal of Cerebro-spinal fluid, but no such results occurred in the cases examined here. Some observers have found variations in blood-pressure following this operation, and believe that in some patients this may bring on Syncope. Most authorities believe that 10 c.cs. of the fluid can be withdrawn with perfect safety to the patient, and the results in this series of cases go to uphold this view. With reasonable care and strict aseptic precautions, there does not appear to be any element of risk.

DIFFICULTIES:

For this routine examination it is essential, in order to achieve satisfactory results, that the specimen of fluid obtained be pure and free from contamination. Simple though the operation appear to be, the obtaining of a good sample of fluid is beset with several difficulties. In this series the details in connection with 77 cases are given. In order to get these fluids the operation of Lumbar puncture was undertaken on 119 occasions; on no less than 35 of these occasions a satisfactory specimen could not be got. There were three main sources of trouble -

inability to reach the space, inability to get fluid when the space was reached, and contamination of the fluid with blood. On twelve occasions the space could not be reached; this was sometimes apparently due to contraction of the muscles and consequent deflection of the needle. When a pure specimen of fluid is essential, it is useless to probe the needle about to any extent if the space is not got quickly, as this must cause laceration of tissue with consequent bleeding, and contamination of the fluid with blood. Sometimes no fluid came although the needle was without doubt in the space; this happened on ten occasions, even after the introduction of a stilette. This may be due to very low pressure, to shutting off of the fluid by local adhesions, or possibly there may be a plug in the needle through which the stilette passes, but which again blocks the bore immediately the stilette is withdrawn. On 13 occasions fluid was got which was contaminated with blood, this must occur by a small vessel being pierced during the introduction of the needle. Often such a fluid showed only a slight cloudiness, but even this degree of contamination was sufficient to spoil results, as centrifuging brings down the corpuscles as well as the cellular elements of the fluid; this makes the examination of the cells a difficult matter. The presence of

blood interferes with the tests of Noguchi and Ross-Jones, and a stained slide prepared from such a specimen always has a cloudy appearance. Making these deductions there are left 84 good fluids from 119 operations; when it is recalled that on seven occasions a second fluid was got from a patient already examined there is a total of 77 patients whose fluids were examined.

RESULTS OF THE EXAMINATION.

Pressure:

The pressure under which the fluid escaped showed considerable variation. In the General Paralytict it was increased in 20% only of the cases, in the cases due to alcohol in 40%, and in the Functional cases in 50%. It was increased in all the cases of Confusional Insanity, and of Melancholia. Most observers agree that there is no very constant variation in the pressure. Schaefer⁽¹⁾, however, came to the conclusion some years ago that the pressure is increased in all forms of Mental disorder and especially so in General Paralysis. Dr Ernest Jones⁽²⁾ has recently stated that the pressure is increased in General Paralysis. The present series, on the other

hand, gives a larger percentage of cases with increased pressure in those suffering from purely Functional disorders, and in many cases of General Paralysis the pressure was very low. It is interesting to note that the pressure was uniformly high in Melancholia, in which disease the blood pressure is always increased. The variations in pressure were, however, so irregular that no definite relation was found to exist between the degree of pressure and the other factors present.

Appearance:

The general appearance did not differ from that of normal fluid. The common cause of altered appearance was contamination with blood. In every case, except one, the fluid when pure was clear and limpid. In this isolated case it had a greenish tinge; this circumstance was not however associated with any fundamental change in the other characters of this specimen. Any opacity and cloudiness were found on further examination to be due to the presence of blood. The fluid in the various forms of Insanity does not differ in appearances from normal fluid.

Reaction:

In every case the reaction as tested by litmus

paper was found to be faintly alkaline.

Specific Gravity:

The specific gravity was found to vary within narrow limits. The highest recorded was 1008.75, and the lowest 1005.5; usually it was 1007 or 1007.5. There was no constant variation, and it appeared to vary as much in the purely Functional cases, as in those with definite brain lesion. In an Imbecile - not included in this series - it was found to be 1009.5. Most investigators have found little constant change in the Specific Gravity, but G. S. Williamson⁽³⁾ in a series of cases examined found that it was high in General Paralysis; he reported cases in which it was from 1009 to 1012. The result arrived at from this investigation was that there is no correspondence between the specific gravity and the form of mental disorder. The amount of Chlorides usually varied directly as the Specific Gravity - a low specific gravity was usually found to co-exist with a smaller amount of Chlorides.

The Noguchi Reaction:

This was described by Dr Noguchi of New York in 1909.

This reaction was found to be distinctly positive



in 28 out of the 32 cases of General Paralysis. In the cases of Confusion it was positive in one only - and that a case which exhibited manifestations of General Paralysis. In those suspected of suffering from Paralysis, it was present in six out of the eleven cases. In the cases due to Alcohol it was positive in two out of ten; while in the functional cases it was positive in four out of 15. It is interesting to note that it was negative in the case of Congenital Syphilis. Noguchi states that he has found the reaction positive in Parasyphilis, and negative in such cases as Alcoholic Psychoses, Dementia Praecox and Imbecility. Mott⁽⁴⁾ has got a positive result in many non-specific cases, and believes it is positive in all cases of Dementia, whether specific or non-specific. He believes the amount of precipitate is proportional to the degree of degeneration of nervous tissue, and that the result is relative, and is well marked in General Paralysis not because the disease is specific but because in this disease there is well marked degeneration in the Nervous System. Ross and Jones⁽⁵⁾ found that the test is positive in all cases of Syphilis or Parasyphilis that had not had recent treatment, and is negative in other cases. John Turner⁽⁶⁾ comes to the conclusion that it is not an absolutely specific test, as

he found a negative result in three cases of General Paralysis.

In this series, the test was applied in every case, and the conclusion arrived at was that the results given are relative. Most of the cases gave a certain amount of precipitate, and the quantity varied from a scanty to a dense precipitate. In many of the instances in which a negative result is tabulated, this conclusion was come to because a precipitate was got which was considered too scanty to admit of the result being regarded as positive. The result was only counted as positive when the precipitate was bulky. It will thus be seen that some experience in this test is necessary before one is in a position to say definitely whether the result in a given case is positive or negative, and there are always cases in which it is extremely difficult to give a decided opinion.

The most bulky precipitates always occurred in cases of General Paralysis, and on the average this disease gave a much more definite result than did any other form of Mental disorder. A positive result was got in most cases of Dementia Paralytica, but in a few cases of this disease no positive result could be got, while a positive result was got in a few isolated cases of Mental disorder which were not para-

syphilitic. A positive Noguchi is strong presumptive evidence of General Paralysis, and any patient whose fluid gives a positive result, if not the subject of General Paralysis, is most certainly suffering from a very serious disorder. The more marked the reaction, the more serious is the condition of the patient, and the worse is the Prognosis.

The Ross-Jones Test:

This test was described by G. W. Ross and Ernest Jones of Toronto in 1909.

This test was applied in 24 cases. Of these eleven were suffering from General Paralysis, and in three the diagnosis had been made of doubtful Paralysis; in these 14 cases the test was positive - a decided reaction appearing in the space of three minutes. The remaining ten cases were made up of Confusional Insanity, Huntingdon's Chorea, Dementia following on Lead-poisoning, and Congenital Syphilis - one of each; and Functional Insanity, and Mental Disorder following on Alcoholic excess - three of each. In none of these ten cases was a positive result got, and they were all decidedly negative except the case of Huntingdon's Chorea which gave a doubtful result. In General Paralysis a result is got very quickly, in all of the cases a decided precipitate

being seen between the two layers of fluid within three minutes. If no result appeared within this period, the test was considered negative. The more quickly this layer appeared, and the denser the layer was, the more decidedly positive was the reaction. All the cases in which this test was positive gave a positive result to Noguchi's test. In one of the cases of General Paralysis (No.93) the result was rather slow in appearing, and it is interesting to note that in this case the Noguchi test, though positive, was not so well marked as in the other cases of General Paralysis in which both tests were applied.

This test, being only recently described, may still be regarded as on its trial. Ross and Jones⁽⁵⁾ found this test positive in all the cases of General Paralysis examined. They also found that this test was positive in every case in which Noguchi's test was positive, and that it was negative where this latter was negative. John Turner⁽⁶⁾, who has employed this test in the fluid from 95 cases of Insanity, finds it positive in all cases of General Paralysis; he got a positive result in only one non-Paralytic case - that being a case of Syphilis of the Nervous System. Comparing this test with Noguchi's he holds that it is a much more specific test - the results given by it being "more definite and clear

cut" than those given by the Noguchi Test.

The conclusion arrived at from a study of the results in the series under review is that this test is specific for General Paralysis. It was found positive in all the cases of Paralysis examined, and in the other cases it was positive only in three cases in which Paralysis had been suspected and in which subsequent events made the diagnosis of Paralysis certain. Comparing this test with the Noguchi reaction, results show that the findings by the Ross-Jones test are much more exact. Noguchi's test is positive in most cases of Dementia Paralytica, but this test is positive in all such cases, and in no others. Of course it was applied in fewer cases than was Noguchi's test, but still the results were so uniform that a quite definite conclusion was arrived at. Noguchi's test is relative, a positive result depending not on the presence of a precipitate but on the amount of this precipitate; while the Ross-Jones test is absolute, the presence of a precipitate within three minutes indicating a positive result.

This Ammonium Sulphate test is a very useful one; it is simple in its application, precise in its results, and the information given by it is definite. In any case where the diagnosis of General Paralysis is in doubt, the application of this test is quite

sufficient to confirm the diagnosis.

Albumen:

The amount of albumen present in the various cases examined was found to vary within wide limits - the lowest being .025%, and the highest .3%. In General Paralysis the amount of albumen was always increased, in most of the cases it was .1% or over. In one case it was as high as .3% and in another .2%. In only one case of General Paralysis was the albumen below .05; here it was .03 on the first examination, and .04 three months subsequently. It is interesting to note that in this case though the signs were well marked, the disease was non-progressive. In advanced cases the amount of albumen was always greatly increased. Those with a marked increase always gave a positive reaction to the Noguchi and Ross-Jones tests; and where Noguchi was negative, the amount of albumen was usually not higher than .05. Excess of Albumen and a high cell count go together. In the cases of suspected Dementia Paralytica, excess of albumen was got in those cases which gave a positive reaction to the Noguchi and Ross-Jones tests. In the cases due to Alcohol .05 is a common result, in only two cases was the quantity higher than this. In the Functional cases it is rare to

get an amount in excess of .05%. In one of the cases following on Lead-poisoning the amount was .075. In the case of Imbecility following on Congenital Syphilis there was no increase.

The amount of protein present in normal fluid is never in excess of .03%, albumen being absent. Albumen is stated by Mott to be present in Acute and Chronic Inflammatory conditions of the Meninges - in fact in all conditions where there is a Leucocytosis and also in cases of progressive degeneration of the Central Nervous System. In 1903 several Continental observers found increase of albumen in chronic mental disorders; Nawratski⁽⁷⁾ found the amount in General Paralysis to vary between .047 and .169 with a mean of .089%. Schaefer found it in General Paralysis to be between .075% and .35% with a mean of .123. He also found in Secondary Dementia and Congenital weak-mindedness a percentage between .03 and .05. John Turner believes a high protein content to be almost as characteristic of General Paralysis as a Lymphocytosis or a positive protein reaction. Flashman and Butler⁽⁸⁾ say:- "There is no room for doubt that apart from acute or subacute diseases a heavy flocculent precipitate occurring in a Cerebro-spinal fluid on the addition of a general albumen precipitant is very strong evidence that the fluid was

derived from a case of General Paralysis or Tabes."

From these references it is clear that the amount of albumen in the fluid is regarded as being a point of very great importance, and all observers are agreed that an excess of albumen is always present in General Paralysis. The present investigation quite bears out this contention. An excess of albumen indicates profound change in the Central Nervous System. General Paralysis always shows an increase, and in this disease the amount is often very great. In other cases it is in those of a graver nature that a large excess of albumen is got, and the greater the excess the more serious is the condition of the patient; and in such cases if the amount is above .05 the outlook is very bad. It will thus be seen that a quantitative estimation of albumen is of the greatest importance in the examination of the fluid from any case of Mental disorder, and this test alone conveys very definite information with regard to diagnosis and prognosis. The amount present appears to be in direct proportion to the gravity of the condition of the patient. In all the cases examined a marked increase occurred only in cases where there was serious damage, and the more albumen present the worse was the state of the patient. This test is of value in all classes of

mental cases, as even in Functional cases a large increase of albumen was found only in those where the prognosis was bad. A percentage of .05 appears to be the dividing line as regards an estimation of the amount of damage done to the Nervous tissue. If the amount is above this the prognosis is bad, if below this then the amount of damage done may be compatible with the patient's recovering at least partially. If the amount is .1% or over, the case is almost certainly one of Dementia Paralytica, whereas if the amount is .03 or below there is in all probability no marked deterioration in the nervous elements.

Chlorides:

A quantitative estimation of Chlorides was made in 43 cases, 17 of these were suffering from General Paralysis, while the remaining 26 were of various types of Mental disorder. The results are given in percentages of Chlorides present. The lowest percentage recorded was .68, the highest .76, while .7 or .72 was about the usual finding. The normal amount of Chlorides present in the fluid is given as varying from .6 to .7, so that the cases examined showed very little variation from the normal. The larger percentages were as a rule found in the cases in which the Specific Gravity was high. No definite relation was

found to exist between the amount of Chlorides present and the form of Mental disorder.

CYTOLOGY:

The investigation of the cells of the Cerebro-spinal fluid, both as regards an actual count, and a description of the various cellular elements, is of great interest and importance. The results of the examination of the cases detailed here show a considerable range of variation in the number of cells present. Looking over the cases of General Paralysis it is seen that with only one exception they exhibit a high cell count. In this isolated case there was found only an occasional cell in the fields. In all the other cases at least three cells were found to the field, and most of them showed a much greater number. The highest number recorded was 61 to the field, usually the number is twelve or higher, and very often there is a count of between 20 and 30. In those cases that from the clinical standpoint were doubtful General Paralytics, a cell count was often found sufficiently large to make the diagnosis certain. Of the other cases, a count of three is got in the case of Confusional Insanity that exhibited definite signs of General Paralysis, and in several of the cases ascribed to alcoholic excess there is an

increased count. No increase is got in the purely Functional cases, nor in those due to Plumbism and gross brain lesions; nor in the case of Huntington's Chorea; here at most only a few isolated cells were found.

The cells found were divided roughly into Lymphocytes and other cells. In General Paralysis a distinct increase of Lymphocytes was found in almost all the cases examined; there were only three cases in which a Lymphocytosis of at least three to the field was not got. Usually there were from eight to twenty to the field, and in some cases the count was very high, 54 being recorded on two occasions. Several of the cases where General Paralysis was suspected showed a definite Lymphocytosis, and in one of these the count was as high as 33. In none of the other cases was there a distinct Lymphocytosis, sometimes an occasional Lymphocyte was found, in others none at all were seen.

A good deal of attention has been given of late to the number and varieties of cells found in the Cerebro-spinal fluid in morbid conditions. The normal fluid contains practically no cellular elements, and all observers are agreed that an increase in the cellular content is of the highest importance as an indication of the severity of the condition. Ernest

(2) Jones says that in General Paralysis the cell count is almost always increased; he considers that a high count found in a chronic disease means General Paralysis or Tabes or possibly Tertiary Syphilis - the count in Parasyphilis being larger than that found in Syphilis of the Nervous System. He also draws attention to the character of the cell picture, and states that General Paralysis shows a variety of cells not to be found in any other disease - "the number of different types is so great as to be indeterminate". He finds that usually two thirds of the cells present are Lymphocytes. Mott believe that a Lymphocytosis indicates a chronic affection of the Meninges, he finds it to occur almost invariably in General Paralysis. John Turner⁽⁶⁾ believes that a cell count is very helpful in diagnosis. He found a Lymphocytosis in 44 out of 50 cases of General Paralysis; and in 45 cases of other forms of Insanity only three showed an increase of lymphocytes, and in these cases it was a slight increase.

The results given in the cases examined in this series entirely coincide with those of other observers. In practically all the cases of General Paralysis a high cell count was found, and most of them revealed a definite Lymphocytosis. In non-paralytic cases a high cell count was extremely rare, and a marked in-

crease of Lymphocytes was never found.

For the purpose of cytological examination Leishman's stain was found to be much more satisfactory than Jenner's, as when stained by the latter method the cells were extremely difficult to distinguish from each other. Jenner's stain does not appear to be suitable for this work, and the results, compared with those obtained by this stain in the examination of blood, are very disappointing. Leishman's on the other hand gives a very distinct cell picture, and when the fluid is free from blood-contamination this stain can be relied upon to give satisfactory results. When there is contamination it is impossible to make a satisfactory cytological examination.

Stained by Leishman's method the Lymphocyte is well stained. The nucleus is large and round, it appears to show little structure, but on careful focussing a certain amount of structure is made out. The chromatophilic granules are then seen to be arranged in a definite manner which gives the whole a faint resemblance to a clock face. Of the other cells present it is rather difficult to speak with any degree of certainty. Many of them appeared to have undergone considerable degeneration, the nucleus was indistinct and the cytoplasm ragged. Some of

these degenerated cells looked like altered Lymphocytes. These cells were most common in the fluids of General Paralytics. If, as some authorities state, these degenerative changes are largely due to cytolytic action on the part of the fluid, then it seems that the fluid in the case of General Paralysis possesses this power to a greater extent than does the fluid in other mental states.

In some cases of General Paralysis plasma cells were found. These cells are larger than Lymphocytes, the nucleus is usually eccentrically placed, is well defined, and is round, oval, or reniform in shape. The nucleus shows more definite arrangement of the chromatophilic granules than occurs in the lymphocyte; here there is a distinct resemblance to a clock face. These cells were found only in certain of the cases of Dementia Paralytica; they were never found except in cases of well marked General Paralysis.

The cells in non-paralytic cases have no distinctive characteristics; they are granular, and appear degenerated, and they exhibit little differentiation.

From the description of the results given above, it will appear that very definite information is to be got from the examination of the fluid in cases of

mental disorder. The results detailed here agree on the whole with those arrived at by other observers. While the examination of the fluid was of interest in every case, it is in General Paralysis that the most characteristic findings are got. The fluid in this disease shows changes which are constant. The amount of albumen is greatly increased, the cell count is high and there is a definite Lymphocytosis; a positive reaction is given to the tests of Noguchi and Ross-Jones. These are results got in no other Mental disease, and if this combination is found to occur there can be little doubt as to the nature of the case.

This examination is a very useful means of settling the diagnosis in a doubtful case. There are many cases in which from a careful examination of the physical signs and mental state a decided diagnosis cannot be made. There are certain cases of Dementia due to Alcoholic excess which are very difficult to distinguish from Dementia Paralytica. There are also patients who present few physical signs, but in whom the mental state is suggestive of General Paralysis. In all such cases an examination of the fluid is a most valuable means of coming to a more definite opinion as to the form of disorder present.

The cases in which a very high Lymphocyte count

was got were always General Paralytics in the early stages before Mental deterioration had become marked; in the very advanced cases the count was usually comparatively small. In those cases in which two examinations were made - the second being made after an interval of three months - the number of Lymphocytes was found to be smaller on the second examination than on the first. This fact that a Lymphocytosis is more marked in early General Paralysis than in the more advanced stages of the disease has been noted by other observers. Some state that a definite Lymphocytosis precedes the physical signs; certainly a distinct Lymphocytosis was found in some of the cases in which from an examination of the physical signs alone a certain diagnosis could not be made. The fact that a Lymphocytosis is an early manifestation of Dementia Paralytica greatly enhances the value of the examination of the fluid as a means of diagnosis, for it is in early cases in which the picture is not complete that the diagnosis is most often in doubt.

There can be no doubt that in the examination of the fluid obtained by lumbar puncture we have got a most valuable addition to the means of accurate diagnosis in General Paralysis. With this method at hand a decided opinion can be given with regard to a

doubtful case; and the results of a lumbar puncture taken in conjunction with a careful examination of the physical signs and mental state will confirm the diagnosis in any doubtful case.

In Functional cases the value of this method of investigation is chiefly a negative one, in that it excludes the possibility of the existence of General Paralysis. But even in such cases there is some positive information to be got, as an indication of the seriousness of the condition can be got from the quantitative estimation of the albumen present. The more albumen present, the more serious is the condition, and the worse the outlook. In such cases the other tests usually give negative results, but if the percentage of albumen is .05 or higher, the prognosis is undoubtedly bad. The conclusion is thus arrived at that in any case of mental disorder, an estimation of the amount of albumen present is important as a means of determining the degree of morbid change, and so of giving a more definite prognosis.

We thus see that an examination of the Cerebro-spinal fluid is of great value in all cases of mental disorder, and gives very definite information both as regards diagnosis and prognosis. The knowledge thus gained is often sufficient to put us in a position to state whether there is a reasonable chance of the

patient recovering or not.

This method of diagnosis, like similar complicated clinical methods, has its limitations, and gives the best results when studied along with a careful examination of the physical signs and mental state of the patient. In his recent book on Clinical Methods, Dr Horder⁽⁹⁾ very accurately sums up the position with regard to such tests when he says that "to add to sound clinical observations the findings of the microscope and the test-tube sums up all the notable advances in medicine since the days of Laënnec The whole truth will never be found at the bedside, still less will it be found in the laboratory; the hopes of medicine lie in the close dependence of each field of observation upon the other".

BRIEF SUMMARY OF RESULTS.

- (1) Lumbar puncture, if reasonable precautions be taken, is an absolutely safe operation, and its use is quite justifiable as a diagnostic measure.
- (2) The examination of the Cerebro-spinal fluid gives valuable information in cases of Mental Disorder.
- (3) The results got in General Paralysis are definite and quite characteristic of that disease, and of no other.
- (4) The following are the chief findings in General Paralysis:-
 - (a) Great increase of albumen.
 - (b) High cell count with a lymphocytosis, and usually the occurrence of plasma cells.
 - (c) Positive reaction to the Noguchi and Ross-Jones tests.
- (5) It is thus a most valuable aid in the accurate diagnosis of this disease.
- (6) The fact that a high cell count and marked Lymphocytosis are more constant in early cases greatly enhances the value of the procedure as a diagnostic measure, as it is in such cases that the diagnosis is most often in doubt.

(7) The test described by Ross and Jones is a specific test for General Paralysis, as it is positive in this disease, and negative in other mental disorders.

(8) The Noguchi test is not a specific test. It gives positive results in all cases where there is marked deterioration of the nerve elements, and for this reason it is usually decidedly positive in General Paralysis.

(9) The amount of albumen present is an estimation of the amount of damage done to the nerve elements, and so enables one to give a more decided prognosis. It is greatly increased in General Paralysis and in all conditions where there is marked deterioration.

(10) If the percentage of albumen is .1 or over, the case is almost certainly one of General Paralysis; if .05 or over the prognosis is bad. While if the amount is as low as .03, it is an indication that the damage done may not be so great as to exclude the possibility of recovery.

(11) In non-paralytic cases the results as compared with those in Dementia Paralytica are chiefly negative.

(12) In such cases the most useful single test is the quantitative estimation of albumen.

(13) The reaction of the fluid is invariably alkaline to litmus paper.

(14) The Specific Gravity varies from 1005.5 to 1009.5.

(15) The pressure shows great variations; it is always high in Melancholia.

(16) The amount of Chlorides present varies from .68 to .76 per cent, thus showing little variation from the normal.

(17) No definite relationship was found to exist between the form of mental disorder and the changes in the fluid as regards Specific Gravity, pressure and amount of Chlorides present.

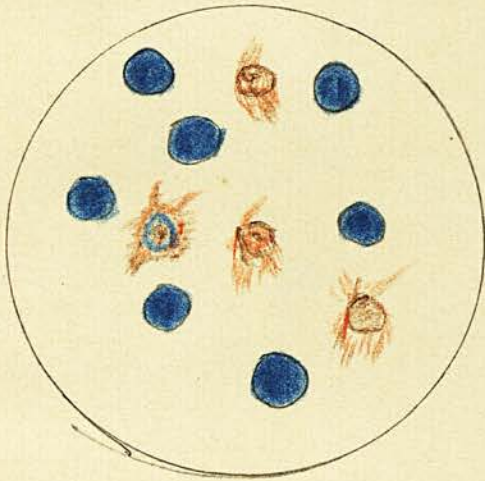
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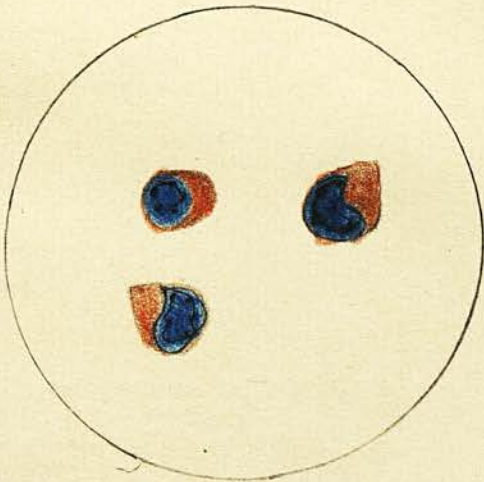
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Illustrations (1)

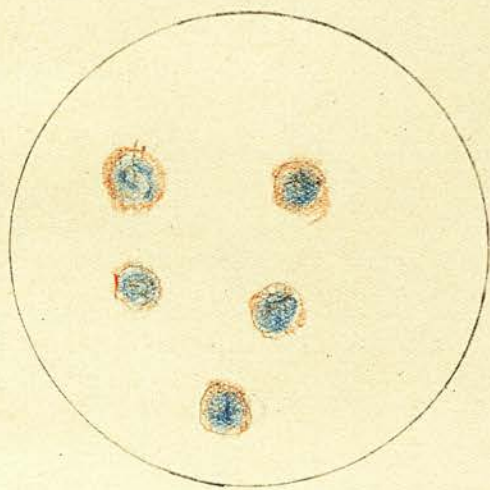
all drawn from slides stained with Leishman.



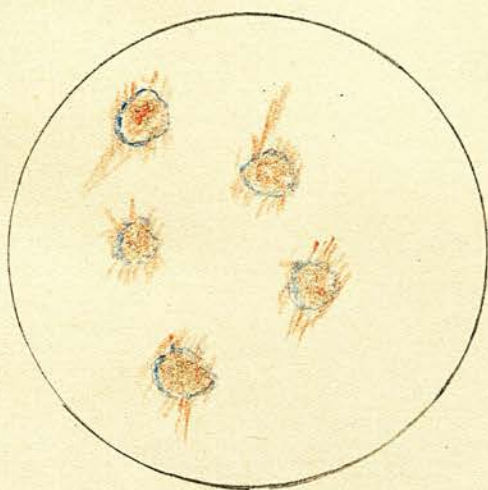
A typical "field" in
General Paralysis, show-
ing a lymphocytosis of
γ with "other cells".



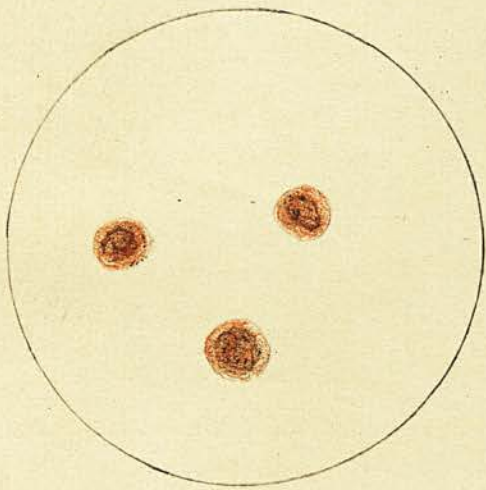
3 Plasma Cells.
Note shape of nucleus
and "clock face".



Degenerated cells
from General Paralysis
possibly altered
Lymphocytes.



Degenerated cells of the
type usually found
in General Paralysis.



Indefinite cells from a
non-Paralytic case.